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# CONTROL OF PURPLE SCALES, WHITEFLIES, AND CITRUS RED MITES ON GRAPEFRUIT TREES WITH PHOSPHORUS INSECTICIDES

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Experiments between 1949 and 1953 demonstrated that heavy infestations of purple scale (*Lepidosaphes beckii* (Newm.)) on grapefruit trees could be kept under control with two or three sprayings of parathion per year (1). This material did not control the citrus red mite (*Metatetranychus citri* (McG.)), however, and in some cases the number of mites tended to increase (2). Heavy and damaging infestations of scale insects and citrus red mites often develop on grapefruit if scalicides and miticides are omitted from combination sprays. The problem was solved by adding a summer miticide, usually ovex, to the combination spray containing parathion, but it increased the cost of spraying considerably.

In 1953 when several organic phosphorus insecticides became available, it was thought that one or another of them might control both scales and mites, as well as the whiteflies *Dialeurodes citri* (Ashm.) and *citrifolii* (Morg.), and prove to be an acceptable substitute in the spray program for these two rather expensive materials. In some experiments early in the year on the control of citrus red mites on Temple orange trees, demeton at 1 pint of 21.2-percent emulsifiable concentrate and malathion at 2 1/2 pounds of 25-percent wettable powder per 100 gallons had appeared promising (3). These materials were therefore included in new experiments.

## Procedure

In a grove of bearing Ruby grapefruit trees experiments were arranged in ten randomized blocks of six trees each, each tree in a block for a different spray treatment. Parathion plus ovex was used largely for comparison with demeton and malathion. In the spring,

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[1] Assisting in these experiments were Raymond E. Nute, Charles E. Smith, Eugenia C. Parker, and James L. Sligh. The grower-cooperator was Norman G. Platts of Fort Pierce, Fla.

March or April, the materials were added to different tanks of the combination spray, which contained basic copper sulfate for control of fungus diseases, zinc and manganese for trace-element deficiencies, and wettable sulfur for control of the citrus rust mite (Phyllocoptruta oleivora (Ashm.)) The trees were given thorough coverage. Again in May or July and in the fall the treatments were used in combination with wettable sulfur, but without copper, zinc, and manganese. A dusting with sulfur on August 20 was necessary in 1953 to prevent russeting by the citrus rust mite.

## Results

The treatments, spray dates, and results of these experiments are given in table 1.

In 1953 excellent control of purple scales was obtained through the entire year from the wettable malathion at 2 1/2 pounds, emulsifiable malathion at 1 quart or 1 pint, and parathion plus ovex. Wettable malathion at 1 1/4 pounds and demeton at 1 pint allowed considerable increases by December. Very good control of citrus red mites was obtained with the parathion plus ovex and demeton sprays. The four malathion treatments were equal in control and were commercially satisfactory. Whitefly populations remained at a low level throughout the year in all plots.

In 1954 infestations of purple scales in the trees sprayed with parathion plus ovex, wettable malathion at 2 1/2 pounds, and emulsifiable malathion at 1 quart were held below one living scale per leaf for the entire year, and results with emulsifiable malathion at 1 pint were almost as good, especially in the middle of the year. Demeton at 1 quart reduced a heavy infestation of 20 scales per leaf to less than 4. Control of citrus red mites and whiteflies was satisfactory from all treatments. In the midsummer sampling (July 23) there were no significant differences. In May slightly larger infestations of citrus red mites were seen after the spray of wettable malathion at 1 1/4 pounds and emulsifiable malathion at 1 pint, but even in these plots the control would have been considered good by growers. In October the four malathion treatments were better in controlling the mites than parathion plus ovex or than demeton, which were equal.

In 1955 the same materials were applied to the same trees except that wettable malathion at 1 1/4 pounds was dropped out. A single oil-emulsion spray of 1.25-percent oil content was used in midsummer on the trees that had been given this malathion treatment in 1953 and 1954, and the concentration in the other malathion treatment was reduced from 2 1/4 to 2 pounds per 100 gallons.

The malathion emulsifiable concentrate at 1 quart and parathion plus ovex at 1 pound per 100 gallons gave the best control of purple scales in 1955, with infestations less than one scale per leaf. Malathion emulsifiable concentrate at 1 pint, malathion wettable powder at 2 pounds, and demeton at 1 quart of 21.2-percent emulsifiable concentrate also gave acceptable commercial control of this scale. The single oil-emulsion spray in July was insufficient for year-round control. This supports conclusions from previous experiments that single scalicide applications cannot be depended upon for year-round control of purple scales on grapefruit trees that have been sprayed with fungicides and minor elements. Control of citrus red mites was satisfactory with all treatments. Superior control was demonstrated by the demeton. Control of whiteflies was not satisfactory, probably because the sprays were timed for control of purple scales. However, after midsummer whiteflies were fewer after demeton than where other materials were used. Considerable control of whiteflies was obtained in all trees by the whitefly fungi Aschersonia spp.

The costs of the scalicides and miticides used in 1955 were calculated from retail prices prevailing at the end of the year. Of these phosphorus materials, 2 pounds of wettable malathion and 1 pint of emulsifiable malathion per 100 gallons were less expensive than the parathion-ovex combination. Emulsifiable malathion did not give distinctly better control at 1 quart than it did at 1 pint, and the 1-quart concentration was more costly than the parathion plus ovex. Demeton at present is too expensive to use as a scalicide, but deserves further study at reduced concentrations for control of the red mites.

## Residues[2]

Residue analyses on grapefruit treated with 2 1/2 pounds of 25-percent malathion wettable powder or 1 quart of 50-percent emulsifiable malathion and picked on November 16, 1954, 21 days after the third spraying, showed no malathion in either juice or rind. Demeton ran 1.02 p.p.m. in the juice and 0.49 p.p.m. in the rind of fruit taken from trees sprayed with 1 quart of the 21.2-percent emulsifiable concentrate, indicating that demeton locates principally in the juice. Whole-fruit analyses for demeton at the same time taken 21 days after the last spraying ran 0.5 p.p.m., and fruits from the same trees taken 28 days after spraying, 0.2 p.p.m. Evidently demeton residues dissipate rapidly after 3 weeks.

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[2] Analyses of parathion, ovex, and malathion residues were made by R. H. Carter of the Entomology Research Branch. Demeton residues were reported by J. W. Young and M. L. O'Connor of Chemagro Corporation.

Residues in or on fruit samples collected on December 6, 1955, 75 days after the third spraying, were 0.07 p.p.m. of parathion for whole fruits and 0.44 p.p.m. for peel only. There were no detectable residues from ovex, malathion, or demeton. Sixteen grapefruit samples picked 20 days after the last spraying of demeton ranged from 0 to 0.3 p.p.m. This is well under the 0.75 p.p.m. set as tolerance for oranges, and suggests that spray concentrations up to 1 quart per 100 gallons would meet the tolerance after a waiting period of 20 days, if the grapefruit tolerance is fixed at 0.75 p.p.m.

With all six treatments there is no suggestion in the residue analyses that the fruits might exceed safe tolerances.

## Summary

Control of purple scales (Lepidosaphes heckii (Newm.)), citrus red mites (Metatetranychus citri (McG.)), and the whiteflies Dioleurodes citri (Ashm.) and citrifolii (Morg.) on Ruby grapefruit trees with three sprayings per year of malathion or demeton without added miticide has been compared for 3 years with sprays of parathion plus ovex. The materials were added to post-bloom sprays containing fungicide, minor elements, and sulfur, and to summer and fall sprays of wettable sulfur.

The results suggest that satisfactory commercial control of heavy infestations of purple scales and citrus red mites on grapefruit trees may be obtained by substituting the single material malathion for the parathion plus ovex now generally used. Control of whiteflies would also be satisfactory in most years. At present prices demeton would be too expensive at spray concentrations necessary for control of the scale insects.

## Literature Cited

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1952. Increases in citrus red mite infestations after the application of parathion sprays. Fla. Ent. 35(2): 87-90.

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1954. New miticides for the citrus red mite (purple mite). Proc. Fla. State Hort. Soc. 67: 42-44.

Table 1.--Effects of sprays containing parathion-ovex, malathion, or demeton on citrus insects and mites.

| Formulation in 100 gal. of spray | Number of living purple scales per leaf | | | | | Percent of leaves infested with citrus red mites | | | | | | Number of whitefly larvae and pupae per leaf | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Experiments in 1953 (Spray Dates March 18-19, May 19-20, and Nov. 3-4) | | | | | | | | | | | | | | | |
| | Nov. 27[1] | June 14 | July 29 | Sept. 23 | Dec. 21 | Feb. 5 | April 6 | May 13 | July 29 | Sept. 23 | Dec. 21 | June 29 | Sept. 23 | Dec. 21 | |
| Parathion (15 WP) 1 lb. + ovex (50 WP) 1 lb. | 0.01 | 0.12 | 0.05 | 0.32 | 0.05 | 1.5 | 0.5 | 20.0 | 7.0 | 55.0 | 8.0 | 1.66 | 1.00 | 0.20 | |
| Malathion (25 WP) 2½ lb. | .00 | .08 | .17 | .96 | .41 | 2.0 | 3.5 | 61.3 | 5.0 | 42.0 | 34.5 | 0.80 | 0.58 | .16 | |
| 1¼ lb. | .01 | .15 | .52 | 1.64 | 3.59 | 0.5 | 7.5 | 60.6 | 2.0 | 40.0 | 61.0 | 1.59 | .46 | .61 | |
| (50 EC) 1 qt. | .00 | .01 | .15 | .62 | .21 | 1.0 | 5.5 | 64.3 | 2.0 | 39.0 | 41.0 | .69 | .46 | .15 | |
| 1 pt. | .00 | .13 | .13 | .70 | .88 | 1.5 | 4.5 | 61.0 | 2.5 | 46.0 | 57.0 | 1.31 | .77 | .30 | |
| Demeton (21.2 EC) 1 pt. | .00 | .19 | 1.11 | 2.00 | 6.12 | 1.0 | 1.0 | 31.0 | 6.5 | 43.0 | 7.0 | 1.19 | .66 | .25 | |
| Difference required for significance 5% | nsd | nsd | 0.32 | 0.66 | 1.38 | nsd | 4.5 | 10.6 | nsd | nsd | 20.0 | 0.61 | - | - | |
| 1% | | | .42 | .88 | 1.85 | | 6.0 | 14.3 | | | 25.5 | .81 | - | - | |
| Experiments in 1954 (Spray Dates April 14-15, July 26-28, Oct. 25-26) | | | | | | | | | | | | | | | |
| | April 12 | July 23 | Oct. 25 | March 31[2] | | April 8 | May 26 | July 23 | Oct. 25 | March 31[2] | | July 23 | Oct. 25 | March 31[2] | |
| Parathion (15 WP) 1 lb. + ovex (50 WP) 1 lb. | 0.48 | 0.08 | 0.29 | 0.18 | | 3.0 | 0.6 | 44.5 | 31.0 | 73.6 | | 1.91 | 4.07 | 0.04 | |
| Malathion (25 WP) 2½ lb. | 4.05 | .18 | .87 | .90 | | 1.5 | 3.6 | 48.5 | 22.0 | 61.6 | | 1.45 | 3.53 | .02 | |
| 1¼ lb. | 8.28 | .92 | 1.76 | 3.23 | | 1.0 | 7.3 | 44.0 | 13.0 | 53.6 | | 1.68 | 3.49 | .08 | |
| (50 EC) 1 qt. | 1.01 | .10 | .50 | .30 | | 1.0 | 1.3 | 45.5 | 16.0 | 59.6 | | 1.39 | 4.05 | .06 | |
| 1 pt. | 3.58 | .19 | .53 | 2.02 | | 1.5 | 6.3 | 44.0 | 16.0 | 58.8 | | 2.07 | 2.65 | .27 | |
| Demeton (21.2 EC) 1 qt. | 20.43 | .98 | 2.06 | 3.94 | | 0.0 | 0.0 | 36.5 | 32.0 | 72.4 | | 1.52 | 3.82 | .14 | |
| Difference required for significance 5% | 3.66 | 0.37 | 0.86 | 2.02 | | nsd | 4.3 | nsd | 9.5 | 11.3 | | nsd | nsd | nsd | |
| 1% | 4.89 | .49 | 1.15 | 2.70 | | | 6.0 | | 12.5 | 15.1 | | | | | |
| Experiments in 1955 (Spray Dates April 13-14, July 13-14, Sept. 22-23) | | | | | | | | | | | | | | | |
| | March 31 | July 13 | Sept. 21 | Jan. 30[3] | | March 31 | May 18 | June 16 | July 12 | Sept. 19 | | March 31 | July 13 | Sept. 21 | Jan. 30[3] |
| Parathion (15 WP) 1 lb. + ovex (50 WP) 1 lb. | 0.18 | 0.27 | 0.05 | 0.04 | | 73.6 | 0.0 | 6.0 | 59.6 | 47.2 | | 0.04 | 3.72 | 10.11 | 2.98 |
| Malathion (25WP) 2 lb. | .90 | 2.13 | .36 | .57 | | 61.6 | 0.0 | 5.2 | 52.4 | 48.0 | | .02 | 6.83 | 14.53 | 5.88 |
| Oil emulsion (90) 1½ gal. [4] | 3.23 | 2.54 | 1.34 | 5.87 | | 53.6 | 0.0 | 5.6 | 55.6 | 16.8 | | .08 | 5.49 | 17.46 | 3.70 |
| Malathion (57 EC) 1 qt. | .30 | .32 | .13 | .18 | | 59.6 | .01 | 5.6 | 60.0 | 48.8 | | .06 | 4.65 | 10.62 | 3.74 |
| 1 pt. | 2.02 | 1.28 | .62 | .62 | | 58.6 | 0.0 | 6.0 | 51.2 | 45.6 | | .27 | 5.22 | 10.12 | 3.34 |
| Demeton (21.2 EC) 1 qt. | 3.94 | 2.00 | .79 | 1.34 | | 72.4 | 0.0 | 1.6 | 27.6 | 15.6 | | .14 | 5.93 | 7.78 | 1.74 |
| Difference required for significance 5% | 2.02 | 1.48 | 0.58 | 1.18 (0.47[5]) | | 11.3 | nsd | nsd | 11.2 | 12.0 | | nsd | nsd | nsd | 1.69 |
| 1% | 2.70 | 1.97 | .78 | 1.58 (0.62[5]) | | 15.1 | | | 14.8 | 16.0 | | | | | 2.26 |

[1] 1952. [2] 1955. [3] 1956. [4] Single treatment on July 13-14. [5] Data from oil-emulsion treatment omitted.

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